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Webinar: Letting Bike Riders Catch the Green Wave

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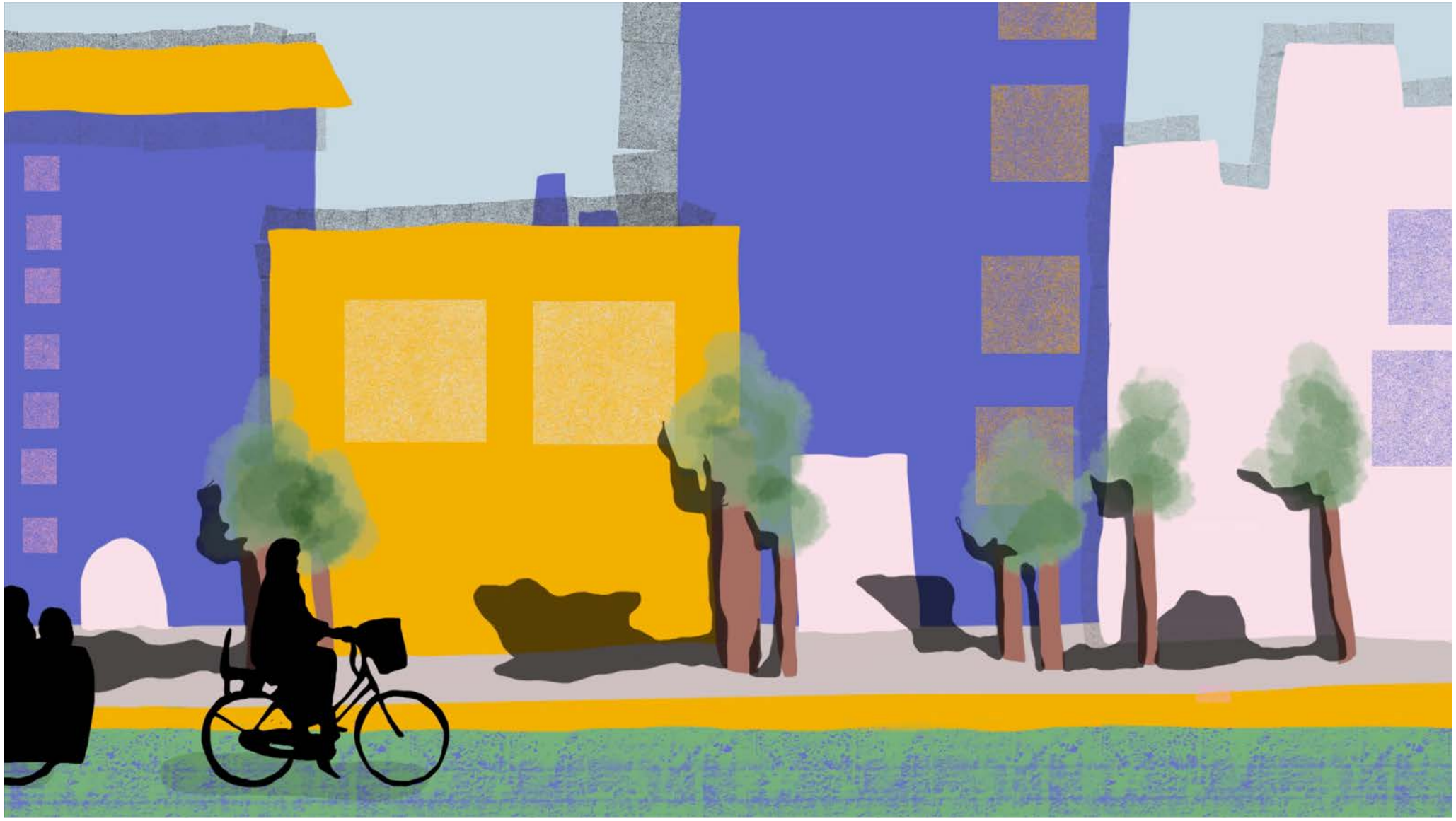
Context: Increasing Cycling

- More people want to bike than environment supports
- Having more trips by bike are critical
  - Environment, health, freedom, social cohesion, affordability, happiness
- Inefficient for most users
  - Lack of protected lanes
  - Signals timed for speed of cars**
- V2X currently car-centric
  - Only get worse with AVs

Signal Timing & Green Waves

- Why traffic signals?
- Types of traffic signals
  - Actuated & Fixed-time
- Two approaches:
  1. Change signal proactively
     - "Bike Connect" system
  2. Change user behavior with information
     - Predictive via machine learning
     - Direct via signal data feed
     - Combination



"Bike Connect"

https://www.youtube.com/watch?v=bbG_2DbML2Y&t=

Animation and narration by Tala Schlossberg

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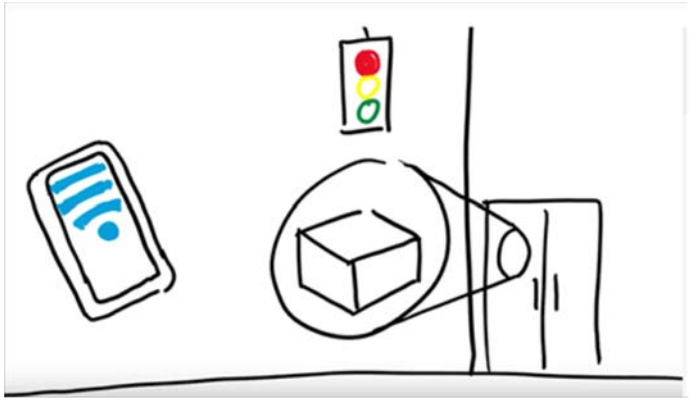
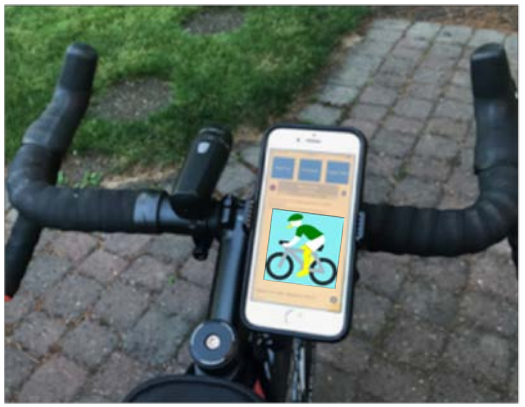
Into the technical weeds…

- Three Projects
  1. Pilot Study 1: virtual calls to bike-signal
  2. Pilot Study 2: green wave on fixed-time corridor
  3. Current study: green-wave for mixed signal corridor

Pilot Study 1: virtual calls

- Cyclist carries phone with Internet connection
- Created an app to predict when cyclists would reach the signal
- Goal: have the app place signal call to optimize likelihood of green while in flow





Test intersection

Phase Timing Bank 1								
Phase	1	2	3	4	5	6	7	8
Walk	0	7	0	0	0	7	0	7
Ped Clear	0	11	0	0	0	11	0	9
Min Green	0	5	7	2	0	5	0	2
Type 3 Disconnect	0	0	0	0	0	0	0	0
Added Per Vehicle	0	0	0	0	0	0	0	0
Veh Extension	0	2	4	2	0	2	0	2
Max Gap	0	2	4	2	0	2	0	2
Min Gap	0	2	4	2	0	2	0	2
Max 1	0	30	18	24	0	30	0	17
Max 2	0	40	18	40	0	40	0	40
Advance/Delay Walk	0	0	0	0	0	0	0	0
PE Min Ped FDW	0	11	0	0	0	11	0	9
Cond. Service	0	0	0	0	0	0	0	0
Reduce Every	0	0	0	0	0	0	0	0
Yellow Change	0	4	4	4	0	4	0	4
Red Clear	0	0.5	0.5	0.5	0	0.5	0	0.5

Vehicle/Ped Vehicle Bike Ped

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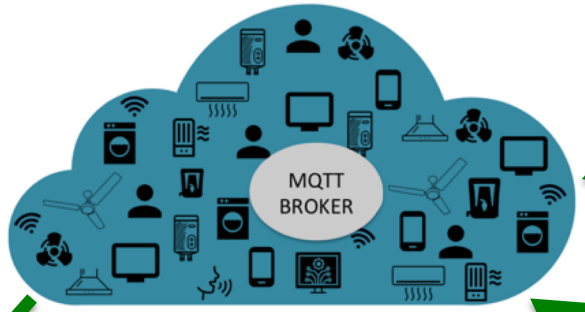
V2X Setup

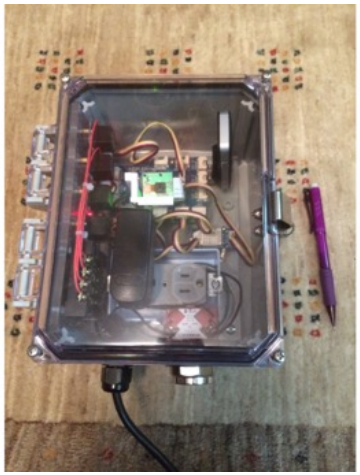


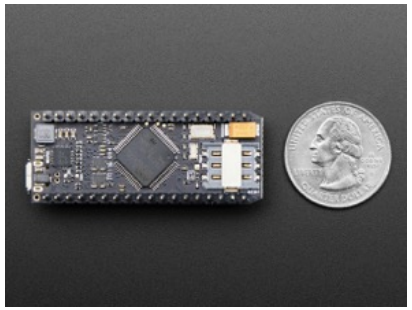
Particle Cloud

Kill Switch

Test Signal

Virtual Call





Particle Electron

Costs:

- Hardware: $200
- Cell: $3/month
- Installation: $2.5K

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Results: Virtual Calls

- 10 riders, 3 months, spring/summer 2018
- App-based recording & user-based feedback per ride if needed
- Majority of the time:
  - Users heard the ‘chirp’ of the app engaging
  - Light was green upon arrival in previously empty intersection
  - Users liked the app – provided positive value to ride

Challenges

- Small study; no control group; user feedback declined over time
- While MQTT supports scale, the logistics of the box defeat scale
- Could do better on “guessing” if had info on current phase state and queue states

Meeting those Challenges

In conversations with the City and the controller manufacturer (McCain) to get access to:

1. Information on current controller state from the McCain cloud & integrate into app; and
2. The ability to place the virtual call through the McCain cloud
   - eliminates the need for the box

Pilot Study 2: User adjusted green wave

- Corridor application
- Fixed-timed signals
  - Signals NOT optimized for cyclist speed
- Use of real-time signal data to predict phase changes
  - As back-up, we can use dead-reckoning data
- Give info to cyclist via app to adjust speed

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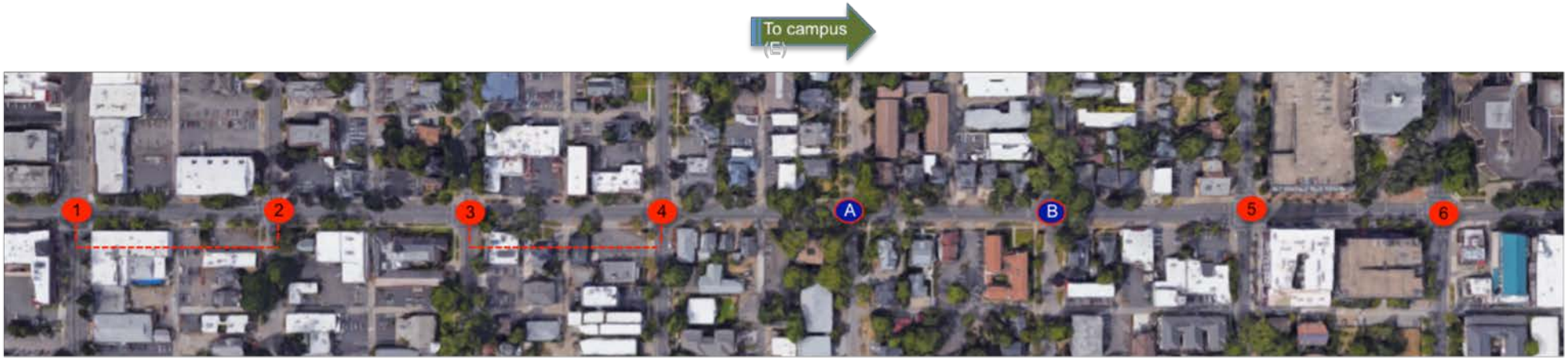
Pilot Study 2: Test Corridor



Signalized intersections:

1: Willamette Street
2: Oak Street
3: High Street
4: Pearl Street
5: Patterson Avenue
6: Hilyard Avenue

Non-Signalized intersections:

A: Mill Street
B: Ferry Street

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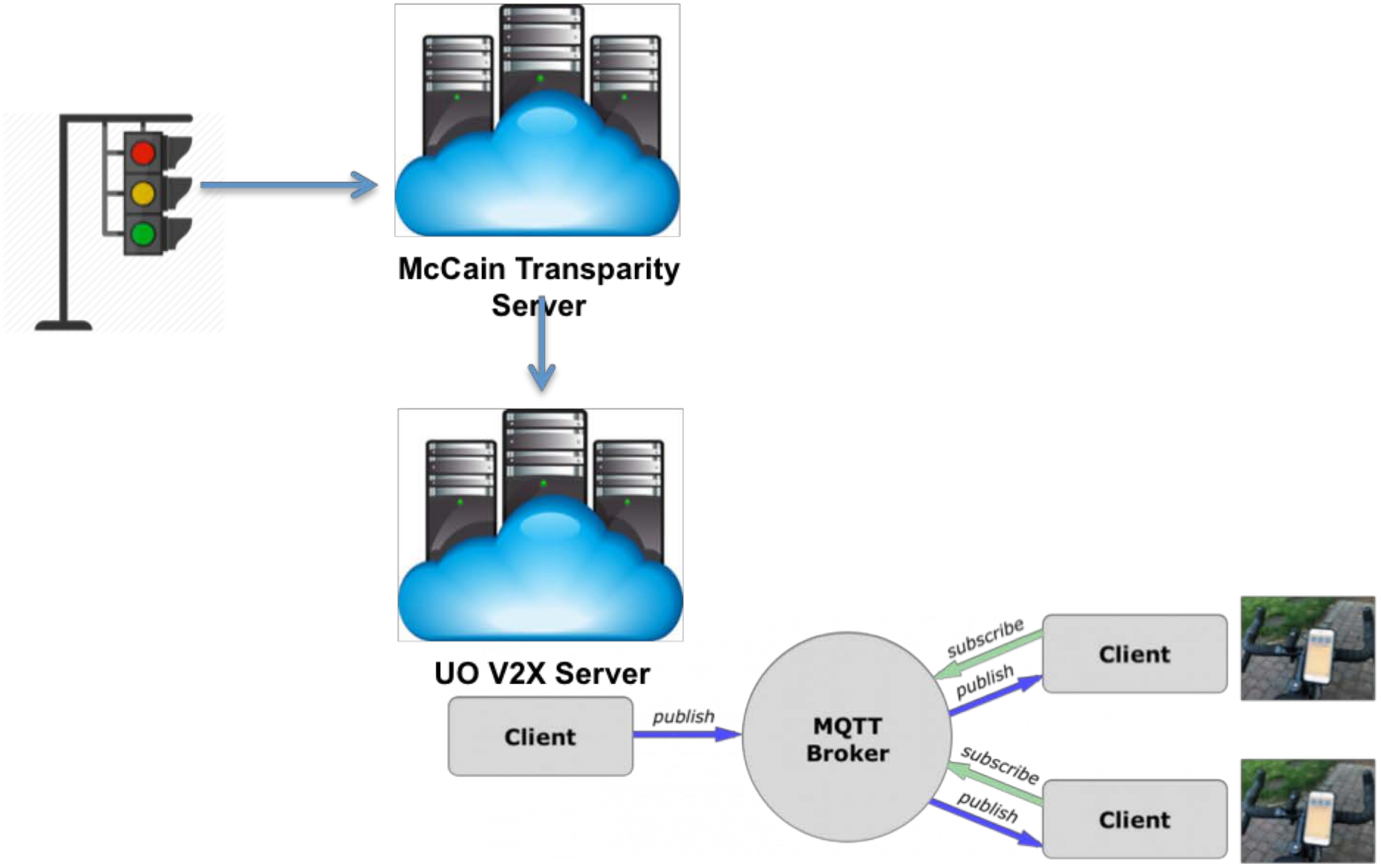
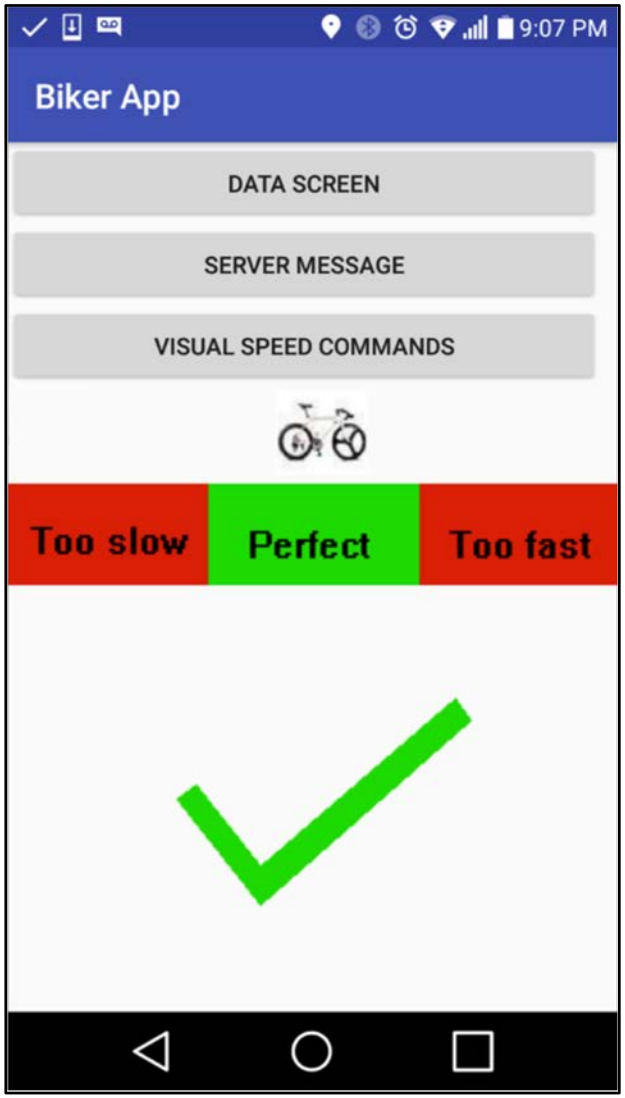
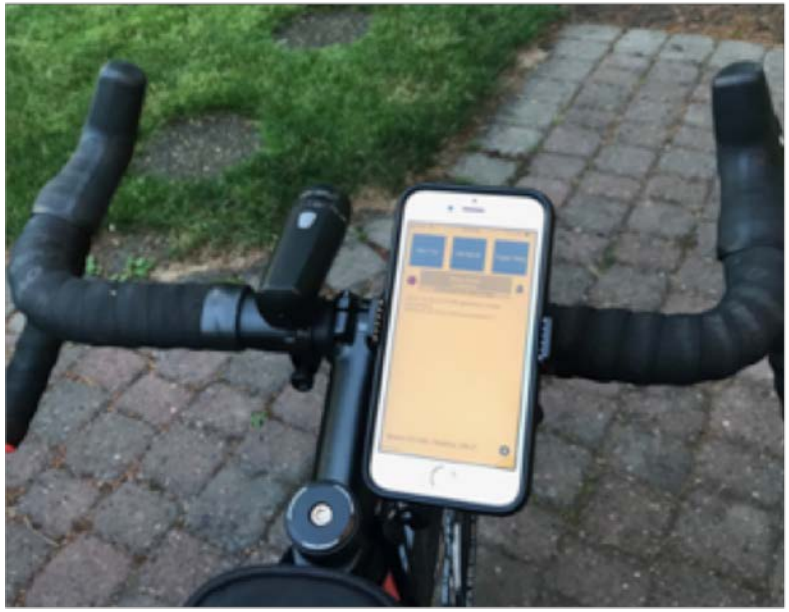
Pilot Study 2: V2X Setup



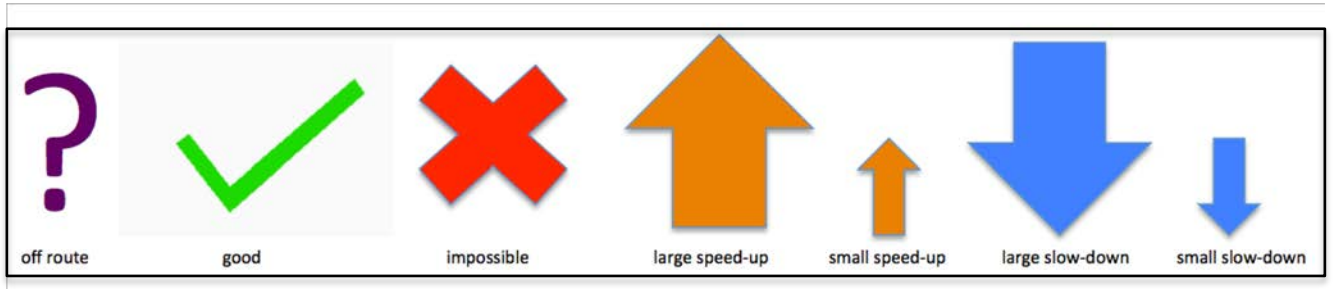
Pilot Study 2: User Interface



App interface



Handlebar-mounted



Possible icons

Pilot Study 2: Results

SLOT	1 -----	----- 2	3 -----	----- 4	5	6
PRE	+	+	+	+	+	0
PRE	+	+	+	0	+	+
PRE	+	+	0	+	+	+
PRE	+	+	+	-G	+	+
PRE	+	+	+	+	+	+
PRE	+	+	0	+	+	+
PRE	+	+	0	+	+	0
PRE	+	+	+	-G	+	+
PRE	+	+	+	+	+	+
PRE	+	+	+	+	+	-R
RUSH	+	+	+	+	+	+
RUSH	+	+	+	+	-E	+
RUSH	+	+	+	+	+	+
RUSH	+	+	+	+	+	-E
RUSH	+	+	+	0	+	0
RUSH	+	+	+	+	+	+
RUSH	+	+	0	+	+	+
RUSH	+	+	+	+	-E	+
RUSH	+	+	+	0	+	+
RUSH	+	+	-R	+	+	-E
POST	+	+	+	+	+	+
POST	+	+	+	+	+	0
POST	+	+	+	+	+	+
POST	+	+	0	+	+	+
POST	+	+	+	+	+	0
POST	+	+	+	+	+	+
POST	+	+	+	+	+	+
POST	+	+	+	0	+	+
POST	+	+	+	+	+	0
POST	+	+	+	+	-E	+

- 30 rides split among 5 riders along the corridor.
- Divided between 3 time-spans: pre-rush, rush, post-rush.
- Provided ride-reporting forms to fill out after each ride.
- Details in paper.

- green (+) – followed directions and found a green.
- yellow (0) – app showed X correctly.
- orange (-R) – app showed X incorrectly.
- purple (-G) – app should have shown X but did not.
- salmon (-E) – other problems encountered (leave notes).

Pilot Study 2: Challenges

- One-size fits all
  - Did not personalize speed parameters
  - At least one participant thought too pessimistic on upper limit.
- Convoys are an issue when inadequate infrastructure bike lane exists
  - Might need to swerve into traffic lane to pass slow moving cyclists

Pilot Study 2: Conclusions

- Works well as ‘band-aid’ on fixed-time routes
  - Syncing signals to average cyclist speed would be better
  - Better (wider & protected) cyclist infrastructure would handle user volume congestion

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FINAL REPORT

V2X: Bringing Bikes Into the Mix

NITC-RR-1027 ■ March 2019

NITC is a U.S. Department of Transportation national university transportation center.

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Final Report 1160
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Fast Track: Allowing Bikes to Participate in a Smart Transportation System

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Current Project

- "Green Waves, Machine Learning, and Predictive Analytics: Making Streets Better for People on Bike & Scooter"
  - Corridor-based
  - Fixed-timed and actuated signals
  - Predictive signal assistance using bikeshare (data and location) (hopeful)
  - Direct, cloud-based signal calls (hopeful)
  - Create screen-less, small-sized, handle-bar mounted, user info device

Catching the Green Wave

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